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OCTOBER ISSSUE, 1929

OPTICAL SOCIETY OF AMERICA

PROGRAM

of the

Thomas Young Memorial Meeting

(Fourteenth Annual Meeting)

CORNELL UNIVERSITY
ITHACA, N. Y.

October 24, 25, and 26, 1929

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PLEASE BRING THIS PROGRAM WITH YOU TO THE MEETING

CALENDAR OF MEETING

All sessions in Rockefeller Hall

Thursday, October 24

8:30 A.M. Registration, Room 220.

9:00 A.M. Lecture Room B.

Address of Welcome by Dr. Livingstone Farrand, President of Cornell University.

Contributed Papers on Radiation and Luminescence.

12:30 P.M. (Sharp) Lunch at Willard Straight Hall.

2:30 P.M. Lecture Room B.

THOMAS YOUNG MEMORIAL SESSION

Invited Papers on Thomas Young and his work.

8:15 P.M. Lecture Room A.

Public Lecture under auspices of the Optical Society of America by Dr. W. F. G. Swann, of the Bartol Research Foundation on "Contemporary Theories Concerning the Nature of Light."

Friday, October 25

9:00 A.M. Lecture Room B.

Contributed Papers on Physical Optics and Instruments.

12:30 P.M. (Sharp) Lunch at Willard Straight Hall.

2:30 P.M. Lecture Room B.

Invited Papers on the Experimental Data bearing on the Theory of Relativity.

7:00 P.M. Dinner* in honor of Professor Edward Leamington Nichols.

Presentation of the Frederic Ives Medal to Professor Nichols. Willard Straight Memorial Room

Saturday, October 26

9:00 A.M. Lecture Room B.

Contributed Papers on Photometry and Colorimetry.

Communication from the Colorimetry Committee of the International Commission on Illumination.

12:30 P.M. Lunch at Willard Straight Hall.

2:00 P.M. Lecture Room B.

Business Session.

Papers Passed at Previous Sessions.

* Dinner tickets ($2.50) may be obtained at registration headquarters, Room 220, on Thursday, October 24.

Those wishing to visit any of the laboratories of the university should inquire at the registration desk. Special arrangements will be made for this purpose.

Thomas Young M.D
Fr. R.S.

This Meeting is Dedicated to the Memory of

Thomas Young

1773–1829

Eminent in

PHILOSOPHY, PSYCHOLOGY

PHYSICS, ASTRONOMY, MATHEMATICS

OCEANOGRAPHY, ENGINEERING, METALLURGY

MEDICINE, ART, ARCHEOLOGY, PHILOLOGY

in Appreciation of His

Outstanding Contributions

to

PHYSICAL, PHYSIOLOGICAL, AND PSYCHOPHYSICAL OPTICS

Er war einer der scharfsinnigsten Männer, die je gelebt haben, hatte aber das Unglück, seinen Zeitgenossen an Scharfsinn zu weit überlegen zu sein. Sie staunten ihn an, aber konnten dem kühnen Fluge seiner Kombinationen nicht überall folgen, und so blieben eine Fülle seiner wichtigsten Gedanken in den grossen Folianten der Königlichen Gesellschaft von London vergraben und vergessen, bis eine spätere Generation in langem Fortschritte seine Entdeckungen wieder entdeckte und sich von der Richtigkeit und der Beweiskraft seiner Schlüsse überzeugte.

HELMHOLTZ

PROGRAM OF SESSIONS

(TITLES AND ABSTRACTS OF PAPERS)

N.B.—These advance abstracts are printed subject to correction of typographical errors. Authors have not seen proof. Corrections should be sent to the secretary promptly. Unless corrections are received before November 4, the abstracts will be reprinted in the Proceedings of the Meeting exactly as they appear here.

Thursday, October 24
9:00 A.M.

Address of Welcome — Dr. Livingstone Farrand, President of Cornell University.

CONTRIBUTED PAPERS ON RADIATION AND LUMINESCENCE

Papers passed at this session may be called at the end of the session or at a later session.

1. E. L. Nichols — **Cornell University**

REVERSIBLE OXIDATION IN LUMINESCENCE

15 Minutes

In this paper numerous instances are cited in the fields of cathodo-photo- and chemi-luminescence which favor the view that reversible oxidation is the general and perhaps the universal cause of luminescence.

The results of new experiments on:

(1) *The effects of ozone in thermo-luminescence,*

(2) *Activators in cando-luminescence,*

are shown to be strongly confirmatory of this hypothesis.

The present paper will appear in full in J.O.S.A. & R.S.I.

2. E. L. Nichols and L. J. Boardman — **Cornell University**

ACTIVATORS IN CANDO-LUMINESCENCE

15 Minutes

The remarkable effects of traces of certain substances in rendering solids fluorescent are shown in the experiments described in this paper to be completely paralleled in the luminescence of incandescent oxides.

The following points are established in this investigation:

As in fluorescence so in cando-luminescence:

(1) The same activators are effective: notably oxides of Cu, Mn, Cr, etc. and the rare earths.

(2) The activator must be in solid solution.

(3) Enhancement increases as the proportion of activator decreases to a definite point (the optimum) then diminishes.

(4) Activation is highly selective; no known solid responds to all activators and no known activator is effective with all solids capable of luminescence.

The present paper will appear in full in J.O.S.A. & R.S.I.

3. D. T. Wilber — **Cornell University**

(Introduced by E. L. Nichols)

LUMINESCENCE FROM CATHODE RAYS

10 Minutes

An investigation of the behavior of the "pure" oxides of thirty three elements under cathode rays in a good vacuum shows (1) The Alkalies are rapidly decomposed and give the arc spectrum, (2) The earths give luminescence without chemical decomposition, (3) The silicon group gives luminescence with slow decomposition, (4) The elements of higher valence give no luminescence but many are decomposed. Some of the latter seem to recombine rapidly under these conditions.

In many cases a bright luminescence at or near the surface appears to be due to the luminescence of the gas evolved, for example the bright blue glow appearing on powdered metallic tungsten as it is degassed by the cathode rays.

The simplest theory of the mechanism of light production in true cathodoluminescence is that the discharge decomposes the molecule which recombines producing light in a similar manner to the magnesium flash light which is clearly oxidation. Continuous oxidation and reduction have already been postulated to explain the luminescence due to the hydrogen flame. Reoxidation may be very slight as in sodium, nearly complete as in zirconium or may take place without the evolution of light as with the higher valence oxides.

An additional activator for alumina is found in manganese which results in a bright green luminescence. (The author acknowledges assistance from the Hecksher Research Council of Cornell University.)

4. Frank E. Swindells — **The Patterson Screen Co.**

FACTORS INFLUENCING THE SPEED OF X-RAY INTENSIFYING SCREENS

10 Minutes

The intensification, or speed factor of intensifying screens is found to increase with shortened development time; to increase with increase of tube potential; to be independent of the tube current from 2 to 35 milliamperes; to be independent of the target-film distance from 0.5 to 2.5 meters; to increase as more filtering medium is interposed between the tube and screens; and to vary considerably with the photographic emulsion used.

Bibliography:

R. B. Wilsey, Radiology, *2*, p. 311; 1924.
F. E. Swindells, Am. J. Roentgenology and Rad. Ther., *17*, p. 115; 1927.
F. E. Swindells, Radiology, *11*, p. 424; 1928.

The present paper will appear in full in J.O.S.A. & R.S.I.

5. H. T. Wensel, Wm. F. Roeser, L. E. Barbrow, F. R. Caldwell — **Bureau of Standards**

THE WAIDNER–BURGESS STANDARD OF LIGHT

15 Minutes

Following out the suggestion made in 1908 by Waidner and Burgess the luminous intensity of the primary photometric standards of the Bureau of Standards has been compared with the brightness of a black body at the freezing point of platinum.

The black body standard was realized experimentally by immersing a tube of fused thoria in a bath of purest platinum (purity higher than .999996) contained in a crucible of fused thoria. The platinum was melted in a high frequency induction furnace and observations of brightness were taken during the period of freezing.

The brightness of the Waidner-Burgess Standard was found to be 58.8 International Candles per sq. cm.

The present paper will appear in full in Bureau of Standards Journal of Research.

6. W. E. Forsythe and F. L. Christison — **General Electric Co.**

ULTRA-VIOLET RADIATION FROM THE SUN AND FROM HEATED TUNGSTEN

15 Minutes

There have been several investigations of the radiation characteristics of tungsten made at the laboratories at Nela Park. Making use of the relations thus found the spectral distribution of energy radiated by tungsten at different temperatures and different wave lengths has been calculated. By step by step integration the intensity of this radiation in different wave length regions was determined. The values used for the energy transmission of the earth's atmosphere and the distribution of energy in the sun's spectrum outside the earth's atmosphere were the published values of Abbot and his co-workers,[1] supplemented for the very short wave lengths by the data of Fabry and Buisson.[2] Using the step by step method of integration the intensity of the radiation from the sun has been calculated for different wave-length regions. From the elevation of the sun and the different air masses involved the intensity of the radiation from the sun at different times of day and different seasons of the year has been calculated for different wave-length regions.

Source	Illumination (foot-candles)	Total Energy (milliwatts per cm²)	Ultraviolet energy falling on a cm² of surface (milliwatts)	
			Below 0.325μ	Between 0.31 and 0.29μ
Sun[a] 1 atm.	8540	107	0.26	0.024
1.07 atm.[b]	7900	97.6	0.21	0.019
1.5 atm.[c]	4940	64.0	0.07	0.0041
2.27 atm.[d]	2415	33.9	0.010	0.00017
500-watt tungsten[e] lamp 1000 hr. life	71	4.0	0.0013	0.00044
500-watt tungsten lamp, 100 hr. life	87	4.0	0.0017	0.00060
900-watt movie[e]	292	9.2	0.0076	0.0028
Tungsten arc[f]	544	11.4	0.030	0.0108

[a] For a horizontal surface.

[b] June 21 for latitude of Cleveland (0.).

[c] About February 15 for latitude of Cleveland.

[d] December 21 for latitude of Cleveland.

[e] Values for the tungsten filament lamps and arc for a cm² at a distance of one meter from the lamp.

[f] Calculated for one cm² of molten tungsten.

Bibliography:

[1] Smithsonian Miscellaneous Collection, *74*, p. 15; 1923. Annals Astrophysical Observatory, *2*, p. 112; 1908.

[2] Comptes Rendues, *175*, p. 156; 1922. Astrophys. Jour., *54*, p. 297; 1921.

The present paper will appear in full in General Electric Review.

7. A. H. Pfund and H. B. DeVore — DuPont Research Laboratory

SPECTRAL SENSITIVITY OF PHOTO-CHEMICAL DECOMPOSITION OF ORGANIC FILMS BY ULTRA-VIOLET LIGHT

15 Minutes

Quartz plates were coated with films of varnishes, etc., and were exposed in a quartz spectrograph to the radiations of a quartz mercury arc—the films being used as photographic plates of low sensitivity. Of the variety of criteria for decomposition viz.: acidity, blushing, yellowing, etc. the latter was chosen because of its wider applicability. Graded exposures ranging from 24 hours to a few minutes were made for each film. The yellowing developed was so slight as to be imperceptible in daylight. However, by resorting to "ultra-violet printing" with radiations around 3100 A.U., remarkable photographs of the mercury spectrum were obtained. Having measured the energies of the various mercury lines with a vacuum thermopile and having determined the absorption coefficients for the various films throughout the spectrum, it was comparatively simple to determine the (yellowing) threshold intensities for equal energy of absorbed radiation. While the spectral sensitivity curves for the various films differ, they all reveal little sensitivity for radiations longer than 3300 A.U. The maximum lies at 3000 A.U. for an ordinary varnish and at 3100 A.U. for a four-hour varnish.

If curves be plotted for "equal yellowing" rather than for threshold, the sensitivity maxima shift toward longer wave-lengths. This is readily accounted for. Experiments bearing on the nature of the yellow film are presented.

8. Brian O'Brien — J. N. Adam Memorial Hospital

SEASONAL VARIATION OF CERTAIN PHOTO-CHEMICAL EFFECTS OF SUNLIGHT

15 Minutes

Using spectral energy curves for the ultraviolet end of the solar spectrum (O'Brien, Phys. Rev., *33*, p. 1072; 1929), and the spectral sensitivity of erythema reaction in human skin (Hausser & Vahle, Strahlthpie, *13*, p. 41; [1921], Hausser, Strahlthpie, *28I*, p. 25; [1928], of bactericidal reaction, protein coagulation, and methaemoglobin reaction (Sonne, Strahlthpie, *28I*, p. 45; 1928), the integrated reactions to sunlight have been computed. The spectral sensitivity curve for the activation of ergosterol has been estimated from its absorption spectrum. All the above reactions approach zero for $\lambda > 3150$A. Thus the product of reaction per unit intensity and intensity approaches zero for $\lambda > 3150$A, and also for wave lengths less than the limit of the solar spectrum. If this product is plotted against wave length, the area of the curve represents the intensity of the reaction.

For exposure at noon, very clear days, lat. 42°27′ N. elev. 1480 ft., if each reaction be taken as 100 units on June 21st, the reactions on Mar. 21st and Dec. 24th respectively are: erythema 32.7, 2.51, bactericidal 25.1, 1.64, protein coagulation 36.7, 3.19, methaemoglobin 38.0, 3.54, ergosterol activation, 36.0, 3.15. For sunlight filtered through a good sample of ultraviolet transmitting glass (thickness 2.1 mm, transmission 42% at 3022A), the reactions in the same units on June 21st, Mar. 21st, and Dec. 21st respectively are: erythema 52.4, 18.6, 1.51, bactericidal 46.2, 12.8, 0.94. For sunlight filtered through a very good sample of ordinary window glass (thickness 2.0 mm, trans. 0.4% at 3022A, 51% at 3300A), the reactions on June 21st are: erythema 2.40, bactericidal 1.23.

The large seasonal variations in the magnitude of the reactions are evident, particularly the reduction near the winter solstice. It is of interest to note that direct sunlight on Dec. 24th produces little more reaction than sunlight on June 21st filtered through the above sample of ordinary window glass.

The computed reactions under sunlight have been confirmed experimentally in the case of erythema reaction.

9. Dr. George H. Maughan — **Cornell Medical College**

THE AMOUNT OF ULTRA-VIOLET RADIATION NECESSARY TO CURE RICKETS AND THE AREA OF THE BODY THROUGH WHICH THE RAYS ENTER IT

15 Minutes

In this paper the author gives the results of experiments conducted to determine the amount of radiation needed to cure rickets in chickens. The area of the body through which the rays enter it was also investigated.

Rickets in chickens can be cured with such uniform results that it can be compared in exactness to a chemical reaction. Because of this fact these animals are valuable in studying ultra-violet problems.

The time necessary to cure severe rickets is approximately twenty-eight days. It requires about one minute daily exposure at 22½ inches lamp-floor distance, or two minutes at 30 inches, to cause 95% cure, when the amperage is 4½ and the voltage is 75 across the arc of a new D. C. Cooper Hewitt quartz mercury burner. Beyond a certain maximum, which is perhaps double these figures, longer treatments show no added benefit.

It seems that there is little difference in rate of recovery if a total of 37½ minutes of exposure is given in four doses of equal length or in twenty-eight daily exposures of 1½ minutes each.

Chickens irradiated from the side require less exposure than those irradiated from above. This difference is likely due to less shading of the feet when the lamp is at the side of the chickens.

Whenever feathers cover the animal as they do the body of chickens six to ten weeks old, they prevent the rays from reaching the skin. The parts which do absorb the vital rays are principally the feet and combs.

Male birds, because of larger combs, usually recover from the disease with less exposure than the females.

Any papers which may have been passed at this session may be called at the end of sessions Friday or Saturday morning or Saturday afternoon.

Thursday, October 24
2:30 P.M.

THOMAS YOUNG MEMORIAL SESSION

(Invited Papers)

10. Prof. H. B. Williams — **Columbia University**

THOMAS YOUNG, THE MAN AND PHYSICIAN

11. Dr. Selig Hecht — **Columbia University**

THOMAS YOUNG'S THEORY OF COLOR VISION

12. Prof. Henry Crew — **Northwestern University**

THOMAS YOUNG AND THE WAVE THEORY OF LIGHT

Thursday, October 24
8:15 P.M.

PUBLIC LECTURE

Dr. W. F. G. Swann — **Bartol Research Foundation**

CONTEMPORARY THEORIES CONCERNING THE NATURE OF LIGHT

The public is cordially invited

Friday, October 25
9:00 A.M.

CONTRIBUTED PAPERS ON PHYSICAL OPTICS AND INSTRUMENTS

Papers passed at this session may be called at the end of the session or at the end of the session Saturday morning or Saturday afternoon.

13. **Charles R. Larkin** — **Lehigh University**

ELECTRIC DOUBLE REFRACTION IN LIQUIDS

15 Minutes

Pauthenier's[1] work on electric double refraction in liquids (Kerr effect) has been repeated with some slight modifications. By the operation of suitably designed and adjusted electrical circuits the plates of the Kerr condenser are charged and the light passed through and extinguished in about 10^{-6} sec. In an interval this short the mechanical electro-strictive effect has not had time to set itself up and is thus eliminated from the result. The change in index of refraction due to heating of the dielectric is held at a minimum by repeating the process only often enough for the eye to integrate the result into a continuous image. The change in optical path due to the field was measured by a Jamin type interferometer. Measurements have been taken for several wave lengths of light between 5000A and 6000A, the strong groups of air lines from a spark being isolated for the purpose. Several liquid dielectrics were used with various impressed potentials up to 10^5 volts/cm. Especial precautions and procedure were found necessary for purifying the dielectrics used. In each case so far studied it has been found that the light whose electric vector is parallel to the field is retarded while the light whose electric vector is perpendicular to the field is advanced, their ratio being -2 within the limit of error of the observations which agrees with theoretical considerations.

Bibliography:
[1] M. Pauthenier: Ann. de Physique, *14*, p. 239; 1920.

14. **E. F. Kingsbury** — **Bell Telephone Laboratories, Inc.**

THE KERR ELECTROSTATIC EFFECT

15 Minutes

The Kerr electrostatic effect has been used recently in a light valve for receiving telephotographs. When an electric field is applied to two parallel plates immersed in a liquid such as nitrobenzol, there are developed between them planes of different refractive indices in the direction of the field and at right angles to it, the difference being proportional to the square of the field. This in general produces elliptic polarization when plane polarized light travels across the field, the axial diameters and positions relative to the field becoming functions of its strength. This is summarized for the various possible adjustments of the system.

Curves are shown of the variation of the light transmission through the analyzer as the voltage is applied for the various polarizer angles and the result of replacing a monochromatic light by white light is discussed. Experimental data obtained with the Kerr cell are compared with the calculated curves. As the system is ordinarily set the transmission is proportional to the square of the sine of the product of a constant and the electric field squared. A better fit is obtained to the experimental data if the exponent to the sine is made greater than 2.0.

For use in telephotography the light transmission characteristic has a restricted exposure range and also considerable curvature at the lower values necessitating an adjustment of the minimum exposure on a flat portion of the characteristic and the inclusion of a non-linear section within the operating range. It is important to use nitrobenzol of low electrical conductivity. Nitrobenzol strongly absorbs ultraviolet and blue light up to about 4400A which decreases its photographic efficiency.

The present paper will appear in full in J.O.S.A. & R.S.I.

15. H. E. Ives and A. L. Johnsrud — **Bell Telephone Laboratories, Inc.**

TELEVISION IN COLOR BY A BEAM SCANNING METHOD

15 Minutes

The object is illuminated by a rapidly moving spot of light, as in monochrome television by beam scanning. Three sets of photoelectric cells are used to pick up the reflected light and produce electrical signals. Each set of photoelectric cells is provided with color filters, so that the response corresponds to one of the three primary color elements, red, green, or blue. Three communication channels are used in place of one. At the receiving end two argon lamps with color filters are used for the green and blue lights, a neon lamp with filter for the red light. A system of semi-transparent mirrors superpose the light from three colored lamps on the eye through a scanning disc pierced with a spiral of holes, on the surface of which the colored image is observed. The conditions necessary for correct color rendering are discussed.

The present paper will appear in full in J.O.S.A. & R.S.I.

16. W. W. Sleator — **University of Michigan**

THE PROPAGATION OF ENERGY BY WAVES

20 Minutes

If rope waves or plane sound waves travel along the x axis, and u is the displacement of a bit of the medium from its equilibrium position, then u is a function of x and t (the time) and $du=(\partial u/\partial x)dx+(\partial u/\partial t)dt$. If $du=0$, $dx/dt=S$, the velocity of the waves, and $S=(-\partial u/\partial t)/(\partial u/\partial x)$ = velocity of medium/condensation. In sound waves or in rope waves any small volume of the medium has *always* equal amounts of kinetic and potential energy ($1/2dS^2=1/2$ stress$\times$strain) and this equality gives S above as $\sqrt{F/m}$ for rope waves and $\sqrt{n/d}$ for sound waves.

In plane waves of light the magnetic and electric fields, representing equal amounts of energy, are together in phase. The question arises, may one write these two fields as time and space derivatives respectively so as to obtain the expression $S=e/\sqrt{e}$ for the velocity of light? Having regard for the vector nature of E and H it is found possible to define a vector quantity u such that Curl $u=D$, electric induction, $\partial u/\partial t=H$, magnetic field. u may be called the "light vector" and its maximum value u is properly the amplitude of the wave. Using this quantity it appears that $S=H/D$, and the equality of energies gives at once $S=e/\sqrt{e}$. The use of U as amplitude gives energy transmitted as proportional to square of frequency. The field of U about an isolated charge has axial symmetry.

17. G. W. Moffitt — **Yerkes Observatory**

ON THE MOUNTING OF CORRECTOR LENSES IN VISUAL TELESCOPES USED WITH STELLAR SPECTROGRAPHS

10 Minutes

The zero power lenses used to adapt the color correction of telescopes designed for visual observation to the requirements of the stellar spectrograph, have certain unavoidable optical limitations. It has often been shown that in order to minimize the effects of these limitations it is better to use correctors of larger diameter placed at correspondingly greater distances from the focal plane.

Usually the mechanical difficulties involved in mounting a corrector lens at a point far up in the tube of a telescope in such a manner that it may be quickly and easily removed or put in place, have led to the use of small correctors mounted rather close to the focal plane.

The mounting of a new corrector at 2½ meters distance from the focal plane in the 40-inch Yerkes telescope will be described as illustrative of a method of mounting that is convenient in operation, and meets the conditions for improved results.

18. **Arthur C. Hardy** — **Mass. Institute of Technology**

THE DISTRIBUTION OF LIGHT IN OPTICAL SYSTEMS

15 Minutes

The distribution of light in optical systems is considered for the case of a source obeying Lambert's law and an optical system obeying the sine condition. As the sine condition can be derived from the conservation of energy principle, such a system represents an ideal case, on the basis of which the efficiency of any actual system can be rated. The method is applied to the analysis of certain well known optical systems composed of spherical or cylindrical lenses or both.

The present paper will appear in full in The Journal of the Franklin Institute.

19. **Joseph Razek and Peter J. Mulder** — **University of Pennsylvania**

(*Introduced by C. B. Bazzoni*)

A BRIDGE GRID RESISTOR AMPLIFIER

15 Minutes

A preliminary report on this work was given at the December 1928 meeting of the American Physical Society. The general equations for the two tube vacuum tube bridge in which grid resistors are employed have been developed. These equations indicate the factors which determine the sensitivity of the bridge.

The conditions to be satisfied in order that the galvanometer current remain steady at high sensitivity are derived from the same equations. These conditions are that the effective characteristics of the tubes be identical in pairs. In practice, this is almost impossible of realization.

A circuit arrangement is given for which these conditions are reduced in number and of such character as to be easily attained. It is shown that stability can be realized even though the tubes differ considerably in their characteristics.

Since it is generally impossible to measure the characteristics with sufficient precision, an experimental procedure for the rapid determination of the operating points for maximum stability is given. Various precautions to be observed in the use of the circuit are described.

The circuit has been used by the writers to amplify photoelectric currents in connection with a spectrophotometer. Many other uses are suggested.

To eliminate the necessity of any batteries, the circuit has been arranged for use on 110 volt A.C. The grids and plates are then supplied from an electron tube rectifier, and the filaments are supplied directly from a transformer. In this form the circuit is used in the recording and indicating Color Analyzer.

Bibliography:

Wynn-Williams, Proc. Cam. Phil. Soc., *23*, p. 811; 1927.

Eglin, J.O.S.A. & R.S.I., *18*, p. 393; 1929.

Mulder and Razek, J.O.S.A. & R.S.I., *18*, p. 466; 1929.

The present paper will appear in full in J.O.S.A. & R.S.I.

20. **F. G. Cottrell, C. H. Kunsman and R. A. Nelson** — **Bureau of Chemistry and Soils, U. S. Department of Agriculture**

A NEW METHOD OF PRODUCING AND CONTROLLING THE EMISSION OF POSITIVE IONS

10 Minutes

A new method for the production and for controlling the emission of positive ions of potassium will be described. The essential part of the apparatus or anode is constructed by fusing a thin-walled potassium glass tube about a platinum strip making sure that a gas-tight seal exists between the glass and the platinum at the two ends. This is now placed in molten potassium nitrate and a considerable amount of potassium electrolyzed through the glass onto

the platinum strip. A thin coating of platinum is sputtered onto the glass by means of a discharge, with the exception of short lengths near the two ends, which are kept free in order to insulate the platinum surface from the central platinum strip. This assembly, when mounted as an anode in a vacuum tube and heated to 625°C by passing a current through the central platinum strip, gives off currents of positive potassium ions up to 10^{-6} amperes $cm.^2$ The emission obeys Richardson's equation. By varying the potential of the platinized emitting surface with respect to the central platinum strip the positive ion current may be varied over a wide range.

The advantages of this source over other sources is quite obvious, in that (1) the emission can be made very pure, i.e., a single alkali as potassium and not a mixture of ions, (2) a large amount of alkali can be electrolyzed onto the platinum strip which assures no decrease in current with time at a constant temperature, and (3) at a given temperature the positive ion currents can be changed by simply varying the potential of the emitting surface with respect to the potential of the hot strip. This relatively low temperature catalytically inactive surface is essential in experiments on gaseous activation by ions where one wishes to reduce the effect of the hot surface to a minimum.

21. K. C. D. Hickman — **Eastman Kodak Company**

MINIATURE CONDENSATION PUMPS

20 Minutes

The efficiency of the Langmuir condensation pump has never been questioned but its utility has been limited by the necessity for water cooling and a liquid air trap.

Both limitations may be removed if a liquid less volatile than mercury is used as the activating fluid. During the last ten years many patents have been granted for pumps using lead, tin, and volatile salts but no mercury substitute has proved satisfactory until the recent introduction of high boiling hydrocarbons by C. R. Burch.

In the present paper an account is given of a number of pure organic liquids which have been tried in place of Burch's hydrocarbons in the diffusion pump. Diffusion pumps are generally too large for the work they have to perform. The capacity of the pump is limited by the connecting tubing and where this must be of small capacity the pump may be made so tiny that the heat losses are relatively great and water cooling may be avoided.

A miniature pump is described to be operated with n-di-butyl phthalate or butyl benzyl phthalate which will yield pressures as low as 10^{-8} mm without a trap and pressures beyond measurement with the ionization gauge when using a trap immersion in ice and salt.

The present paper will appear in full in J.O.S.A. & R.S.I.

At the end of this paper there will be a demonstration of the miniature condensation pump and of the Vacuum Recording Gauge. (J.O.S.A. April 1929.)

Papers which may have been passed at this session may be called at the end of the session Saturday morning or Saturday afternoon.

Friday, October 25
2:30 P.M.

EXPERIMENTAL DATA BEARING ON THE THEORY OF RELATIVITY

(Invited Papers)

22. Prof. Charles Lane Poor — **Columbia University**

THE DEFLECTION OF LIGHT AS OBSERVED AT TOTAL SOLAR ECLIPSES

23. **Dr. Keivin Burns** — **Allegheny Observatory**
A COMPARISON OF SOLAR AND LABORATORY WAVE LENGTHS

24. **Dr. H. R. Morgan** — **U. S. Naval Observatory**
THE OBSERVED MOTION OF THE PERIHELION OF MERCURY

25. **Prof. Dayton C. Miller** — **Case School of Applied Science**
ETHER DRIFT EXPERIMENTS IN 1929

Friday, October 25
7:00 P.M,
(Willard Straight Memorial Room)

DINNER IN HONOR OF PROFESSOR NICHOLS
PRESENTATION OF THE FREDERIC IVES MEDAL TO
PROFESSOR EDWARD LEAMINGTON NICHOLS

Saturday, October 26
9:00 A,M,

CONTRIBUTED PAPERS ON COLORIMETRY

Papers passed at this session may be called at the end of the session or after the Business Session, Saturday afternoon.

26. **F. F. Rupert** — **Mellon Institute**
A STUDY OF PIGMENT PRIMARIES AND MIXTURES
15 Minutes

The use of the spectrophotometer provides the best method for the study of the mixing properties of pigments. In transmission media such as solutions and films, the optical laws by which the effect of mixing may be predicted are simple, but in the case of reflecting surfaces there are many complications. A study of curves obtained from water color washes and dry pigments reveals no simple mathematical relations, but the following principles are established:

(1) When the reflectances of the components, at any given wave length, are equal or nearly equal, the reflectance of the mixture agrees closely with that predicted by formulas applying to transmission; (2) when the reflectances of the components are widely different, the reflectance of the mixture is nearer that of the lower component than predicted. The mixing properties of any pair of chromatic pigments can thus be predicted with fair accuracy. A brief study of oil paints was also made, with similar results in some cases, but the optical properties of the vehicle often introduce additional complications.

Primary art colors may well be defined as the colors of the smallest number of tinctorial media chosen so that any hue with satisfactorily high brilliancy and saturation may be produced by a mixture of not more than two of the media. On the bases of this definition, color analyses of all types of pigments, and the principles given above, it is shown that the broadest sense of the word "satisfactory" calls for three primaries, and that if three are chosen, they must be red, yellow and blue, with narrow limitations imposed upon the form of the spectrophotometric curves of the pigments used.

27. **Clayton H. Sharp** — **Electrical Testing Laboratories**
MEASUREMENT OF FILAMENT TEMPERATURE OF INCANDESCENT LAMPS
10 Minutes

The apparatus has been designed primarily for matching the color of an incandescent body with that of an incandescent lamp calibrated as a standard of color temperature. Use is made of a rotating disc one-half of which is red and the other blue together with a photoelectric cell

connected to an amplifier train in a circuit of such character that the red filtered impulses are opposed to the blue filtered impulses. A condition of balance is reached for only one degree of incandescence but with any other degree of incandescence a balance may be reached by interposing a filter of either bluish or yellowish tint and of the right density. This filter may conveniently take the form of a color wedge.

After a balance is had with the lamp to be measured, the calibrated lamp is substituted for it, and its voltage varied until balance is restored. The corresponding color temperature is read from the calibration curve or the voltmeter may be fitted with a scale reading color temperature directly. The applicability of the method to recording and to controlling devices is pointed out and also the possibilities of its usefulness in matching paints which are of the same basic composition.

28. Peter J. Mulder and Joseph Razek — **University of Pennsylvania**

(*Introduced by C. B. Bazzoni*)

A PORTABLE RECORDING AND INDICATING COLOR ANALYZER

20 Minutes

A portable recording and indicating color analyzer has been developed and built at the University of Pennsylvania. This first model consists of an illumination unit, a spectrometer, a photoelectric cell connected to a bridge grid resistor amplifier, and a recording and indicating galvanometer. These parts are built into a box about the size of a suitcase.

The illumination unit consists of a number of small bulbs arranged on a hemispherical surface, while the sample to be tested is mounted at the center of the sphere. The light reflected from the sample normally is focused by a cylindrical lens on the slit of a spectrometer.

The spectrometer is of the constant deviation type, and is especially designed for high intensity. Both entrance and exit slits are automatically variable, the former in length to compensate for lack of uniformity in the color sensitivity of the photoelectric cell, the latter in width to keep a predetermined width of wave-length band on the photoelectric cell.

The amplifier is as described in the previous paper. It is operated from an ac rectifier unit especially designed for it. This makes it possible to operate the analyzer from any 110 volt ac outlet.

The galvanometer record is photographed, on paper or film as desired, $3\frac{1}{4}$ by $4\frac{1}{4}$ inches in size, suitable for projection. All moving parts are driven directly from the film holder. Coordinates are printed in a separate compartment. An ac voltmeter records the voltage applied to the illumination unit on the same sheet with the reflection factor curve. Both the galvanometer and the voltmeter beams are reflected to a scale for visual observation.

It is expected to demonstrate the present model at the meeting.

Bibliography:

O. S. A. Colorimetry Com., J.O.S.A. & R.S.I., *6*, p. 527; 1922.

A. C. Hardy, J.O.S.A. & R.S.I., *18*, p. 96; 1929.

29. Deane B. Judd — **Bureau of Standards**

THOMAS YOUNG'S THEORY OF COLOR VISION AND THE HUE CHANGE BY ADDITION OF WHITE LIGHT

20 Minutes

When both halves of a photometric field are illuminated by spectral light of the same wave length and intensity, and white light is added to one side of the field, a normal observer will respond (for all but two wave-length regions) that the brighter and paler half of the field is no longer the same hue as the other half. This hue change was first reported in detail by Abney[1] and his results were subsequently confirmed by extensive observation at the Bureau of Standards.[2] Schrödinger[3] ascribed the hue change for red and green to the relatively high saturation of these colors in the spectrum compared to spectrum yellow, and this explanation was suggested independently by me[2] seven years later. The hue change for violet has not yet been explained.

The present work has shown that the three-components theory of color vision will qualitatively reproduce the experimentally established hue change for all wave lengths if the assumption (independently suggested by many other visual experiments) be made that the component for "blue" is less stable to light than that for "red" or "green." This assumption leads to the prediction that the two spectral regions showing no hue change shall be complementary (blue and yellow). We are further constrained to expect that (very pale) red may be produced by violet light merely on the addition of the proper quantity of white light. Both of these predictions have been verified by experiment.

Quantitative prediction has been made possible by the assumption of a specific form of variation with time, t, of the activity of the "blue" component: Activity $= K/(K+t)$, where K is a constant depending on the energy distribution of the stimulus. It has been found desirable to adopt for this purpose a set of primary colors differing slightly from the König Grundempfindungen. The findings of the Young theory extended in this way agree with experiment only semi-quantitatively, but the most serious discrepancies can be referred to the variation in saturation of spectrum colors already noted.

Bibliography:

[1] Abney, On the Change of Hue of Spectrum Colors by Dilution with White Light, Proc. Roy. Soc., A., *83*, 1909.

[2] Judd, The Empiric Relation between Dominant Wave Length and Purity, J.O.S.A. & R.S.I., *14*, p. 475; 1927.

[3] Schrödinger, Ann. d. Physik, (4), *63*, p. 514; 1920. Section 9, Die Farbtonänderung beim Zumischen von Weiss.

30. Irwin G. Priest and J. O. Riley **Bureau of Standards**

THE SELECTIVE REFLECTANCE OF MAGNESIUM OXIDE

10 Minutes

The following factual data pertain to *one* sample of MgO deposited on aluminum by burning magnesium in air. The observed surface was deposited Aug. 22, 1929 on top of a similar deposit already 0.4 to 0.45 mm thick prepared several weeks earlier. The total final thickness was 0.54 to 0.64 mm. The deposit was quite compact, and the grain was very fine (showing hardly any recognizable structure for linear magnifications of over 100). It was apparently a less perfect diffusor than the common $MgCO_3$ blocks. Spectrographic analysis (B. S. spectroscopy section) showed absence of all metals except Mg, Ca (about 0.001%), Fe (less than 0.002%).

R is apparent reflectance, on absolute scale, for line of sight normal to sample surface with illumination completely diffuse. R_d is R for daylight. R_b, R_g, and R_r are, resp., R for light transmitted by very selective blue, green, and red filters (Jena glasses 3654, 4930, and 4512) such that the spectral centroids of light are about 460, 540, and 650 mμ. R_m is the mean of R_b, R_g, and R_r. Values of R_d (for the purpose of describing the sample—not as important new data per se) as follows have been found (by comparison with $MgCO_3$ block for which McNicholas[1] had previously determined $R=0.981$):—Initial 0.4 mm layer 0.97; the observed 0.6 mm layer 0.984; a much thicker (>1.0 mm) layer, 0.987. For the 0.6 mm layer we have found:

$R_b/R_m = 1.0021 \pm 0.0007$.

$R_g/R_m = 1.0016 \pm 0.0005$.

$R_r/R_m = 0.9962 \pm 0.0006$.

Each of these values is the grand mean of 8 determinations by I. G. P. and 4 determinations by J. O. R. (Sept. 8–18). Each of these 12 determinations comprised 10 individual measurements. The probable errors of the several "determinations" (computed from the 10 residuals in each case) range from about ± 0.001 to ± 0.002.

Measurements made concurrently and in exactly like manner with same apparatus verify previous information[2] that $MgCO_3$ is slightly yellow.

We conclude that, *for this sample* of MgO, the reflectance for blue and green is certainly greater than for red; but it is highly improbable that the reflectance for any wave length between 460 and 650 departs from the mean by as much as 1%. The first part of this conclusion has been verified by a separate qualitative experiment showing that the color of MgO (even for layers >0.5 mm) by multiple reflection is certainly blue, green, or blue-green. (Direct comparison of color by multiple reflection with color by single reflection.) This is in direct contradiction of Pfund's finding[2] that MgO in thicknesses greater than 0.36 mm is yellow.

Bibliography:

[1] McNicholas, B. S. Res. Pap. No. 3, p. 53.

[2] Pfund, Jo. Frank. Inst., March, p. 379; 1920.
Hyde, Astrop. Jour., May, p. 239; 1912.

[3] For method of measuring R see following abstract.

31. Irwin G. Priest **Bureau of Standards**

NOTE ON THE YELLOWNESS OF COMMERCIAL MAGNESIUM CARBONATE AND THE ALLEGED YELLOWNESS OF MAGNESIUM OXIDE

5 Minutes

For many years magnesium carbonate in the common form of blocks has been widely used as a standard white material in colorimetric work. However, it has been pointed out that its reflectance in the visible spectrum is actually not uniform but varies with wave length in such a way as to tend to make its color slightly yellow.[1] The yellowness of the sample dealt with in the present report perceptible, by artificial daylight, in a 6° Martens photometer field one-half of which is illuminated by light from the wall of a hollow sphere while the other half is illuminated by light from the sample which itself receives light only from the same sphere wall. The degree of selectivity for this sample is indicated by the following data which were obtained by using the just mentioned viewing device to measure the ratio of the brightness of the sample to the brightness of a fixed area of the sphere wall, with blue, green, and red filters in turn over the photometer ocular:[2]

$R_b/R_m = 0.9917.$

$R_g/R_m = 1.0037.$

$R_r/R_m = 1.0046.$

Subsequent spectrographic analysis (B. S. spectroscopy section) showed about 0.1% iron in this sample, i.e., 50 times the concentration of iron found in MgO which was very nearly non-selective but slightly blue.[2] No other foreign elements except Ca (strong) and Cu (<0.01%) were found.

The well known color of iron oxides at once suggests the tentative hypothesis that the yellowness of common magnesium carbonate may be due to iron present as a slight impurity. It is not inconceivable that the yellowness of MgO reported by Pfund may have originated from the same cause, if special care was not taken to insure the absence of iron, which is notorious as an ubiquitous impurity.

Another possible hypothesis to account for the alleged yellowness of the MgO is the assumption that a small amount of magnesium nitride might be deposited with the oxide. The nitride is notably yellow. It is formed when magnesium is burned in air with insufficient draft to supply an adequate amount of oxygen; and is actually commonly found in the clinker residue resulting from the combustion of magnesium in air.

However, the definitive resolution of the discrepancy between Pfund's findings and our own[2] must await the results of further investigation.

Bibliography:

[1] Hyde, Astrop. Jour., May, p. 239; 1912. Pfund, Jo. Frank. Inst., March, p. 379; 1920.

[2] For meaning of symbols in this abstract and for data on MgO consult preceding abstract by Priest and Riley.

32. **Irwin G. Priest** — **Bureau of Standards**

NOTE ON THE RELATIVE SENSITIVENESS OF DIRECT COLOR COMPARISON AND SPECTROPHOTOMETRIC MEASUREMENTS IN DETECTING SLIGHT DIFFERENCES IN THE SPECTRAL DISTRIBUTION OF LIGHT

10 Minutes

The following question (in effect) has been frequently put: Can spectrophotometric measurements be made with sufficient accuracy to detect and certainly establish the least differences which are perceptible by direct comparison of colors *as colors?* The question has been considered as particularly pertinent in the case of very pale tints hardly distinguishable from white.

The present answer is in the affirmative for particular cases; but it is not affirmed that this answer is general for all cases. Data on the selective reflectance of MgO and $MgCO_3$ are given in the two preceding papers on this program. Additional data by the well known psychophysical method of right and wrong answers in the direct comparison of the two halves of the 6° field in the Martens photometer with high illumination justify the following conclusions:

(1) The slight selectivity of the MgO although definitely measured photometrically is entirely inappreciable by color discrimination under the conditions of observation just specified. (Greatly increasing the field size would tend to enhance the sensitivity but it seems highly improbable that any conditions of viewing would render this difference discriminable with certainty although it might attain the level of a doubtful vanishingly small difference.)

(2) In the case of $MgCO_3$ the perceptibility approaches but does not quite attain certainty. The observer reports the difference correctly in nearly all but not all trials.

Other similar data are also in accord with these conclusions.

On the other hand it should be emphasized that, in many cases, photometric accuracy must be pushed to the extreme possible limit in order to yield data truly significant in specifying color stimuli.

Bibliography:

Pfund, "The Colorimetry of Nearly-White Surfaces," Jo. Frank. Inst., pp. 371–379; March, 1920.

Pfund, "A New Colorimeter for White Pigments . . . ," A. S. T. M. 23rd Annual Meeting, June, 1920.

Priest and Riley, "The Selective Reflectance of Magnesium Oxide," this program.

Priest, "Note on the Yellowness of Magnesium Carbonate . . . ," this program.

COMMUNICATION FROM THE COLORIMETRY COMMITTEE OF THE INTERNATIONAL COMMISSION ON ILLUMINATION

(Presented by Mr. Priest)

The International Commission on Illumination has established an International Colorimetry Committee. The secretariat of this committee has been assigned to Great Britain; and the British National Committee of the I. C. I. has appointed the following British committee to direct these activities:

Mr. T. Smith,	National Physical Laboratory, (Chairman)
Dr. S. J. Barker,	Woollen and Worsted Research Association.
Mr. J. Guild,	National Physical Laboratory.
Dr. W. M. Hampton,	Messrs. Chance Bros.
Dr. L. A. Jordan,	Paint and Varnish Research Association.

Dr. R. Lythgoe, Dept. of Physiology, University College, London.

Dr. L. C. Martin, Dept. of Applied Optics, Royal College of Science, London.

Mr. H. Buckley, National Physical Laboratory, (Secretary).

Representatives of other nations on the International Committee have been appointed as follows:

FRANCE: Prof. Fabry

GERMANY: Dr. Pirani

UNITED STATES: Mr. Priest

It is desired that the national representatives communicate not only their own personal views, but also give the International Committee a fair representation of the views and recommendations of their colleagues in their respective countries; and it is thought that the organization best adapted to securing a synthesis of opinion on this subject in the United States is the Optical Society. With this end in view, Mr. Priest will present to the meeting recent communications from the British Committee and invite discussion of them. Ample oral discussion at the meeting is desired; and it is also requested that this be supplemented by written statements in cases where the comments should be made a matter of record. (There will be no stenographic report of the discussion at the meeting.)

The next meeting of the I. C. I. is scheduled for September, 1931, in London. In the meantime the committee is conducting discussion by correspondence. Current discussion is concerned specifically with:

(1) Adoption and establishment of working standards for "white light" as a standard illuminant in colorimetric work.

(2) A standard method of illuminating test objects for colorimetry.

(3) A standard nomenclature for colorimetry.

The only communication requiring general consideration received to date (September 20) from the Secretariat Committee is appended hereto as a basis for discussion. This communication will not be read *in extenso* at the meeting, it being presumed that those who desire to discuss it will have familiarized themselves with its contents in advance.

On written request, Mr. Priest will be glad to send copies of future communications from the British Committee to Americans who have a technical or professional interest in them, and will also be pleased to receive their written comments and recommendations, whether or not they be members of the Optical Society. Address:

Irwin G. Priest,
Bureau of Standards,
Washington, D. C.

Appendix

COMMUNICATION ON ESTABLISHMENT OF A STANDARD OF WHITE LIGHT FOR COLORIMETRIC PURPOSES RECEIVED FROM THE BRITISH COMMITTEE, JUNE 25, 1929. (DESIGNATED IN THE I. C. I. FILES AS "15 GREAT BRITAIN 1.")

NATIONAL ILLUMINATION COMMITTEE OF GREAT BRITAIN
(Affiliated to the International Commission on Illumination)
OFFICE—
THE NATIONAL PHYSICAL LABORATORY,
TERRINGTON, ENGLAND.

15 Great Britain 1.

Sub-Committee on Colorimetry

The Secretariat Committee is giving consideration to the establishment of a standard white light for colorimetric work. It regards this as a matter of great urgency at the present time in view of the widespread desire among the technical workers in the various colour industries in Great Britain to bring their colorimetric work on to some standard basis. A similar view is no doubt held in other countries, and has found expression in resolution (b) of the Session on Colorimetry, Saranac Inn, 1928. It will greatly facilitate the work of the Secretariat Committee in drafting proposals for standards likely to meet with general acceptance if you will kindly forward, as soon as convenient, a statement as representative as possible of the views prevailing in your country, on the matters herein dealt with.

The Committee had before it a memorandum from Mr. J. Guild of the National Physical Laboratory, a copy of which is enclosed for your information. As the result of discussion the Committee desire to put before the various national representatives certain definite recommendations, which it hopes will be generally accepted, a number of tentative recommendations, and some questions on which it would like the views of these representatives before framing recommendations.

Definite Recommendations.

1. The standard illuminant for colorimetric purposes shall consist of two elements, namely a lamp operated at a definite colour-temperature and a filter to give to the transmitted light an energy distribution of a character which can be generally accepted as representing "white" light for colorimetry.

2. The lamp to be used for the standard illuminant shall be a gas-filled tungsten filament incandescent lamp, operating at a colour temperature determined by following a prescribed procedure framed so as to avoid as far as possible errors arising from discrepancies in the high-temperature scales at present adopted in different countries.

3. The filter shall consist of one or more layers, of specified thickness, of absorbing liquids contained in parallel sided cells of which the walls are made of optical glass of high transparency such as Borosilicate Crown or Hard Crown. The ingredients to be such as are readily obtainable of sufficient purity to enable the filter to be accurately reproduced from its specification.

4. The lamp shall be rated by colour-match on a photometer bench with a Lummer-Brodhun contrast photometer head, employing as a standard of comparison a low-temperature standard lamp operated at 2360°K in combination with a filter to raise the apparent colour temperature to a suitable value (see recommendation 5). That is to say, the standardisation of the gas filled lamp will not be dependent on the attainment of a definite colour temperature of T°K, a problem which different laboratories would attack in various ways with somewhat discordant results but will depend on the attainment of a colour match with standard lamps operating at 2360°K used in conjunction with a specified filter. This procedure is recommended

because at the present time much closer agreement is likely to be obtained by different laboratories in setting up standards of colour temperature 2360°K than would be the case with the higher colour temperatures at which gas filled lamps operate.

Tentative Recommendations.

5. The colour temperature of the gas filled lamp to be aimed at by means of the 2360°K standard lamp and the auxiliary filter shall be about 2900°K.

6. The auxiliary filter shall be a liquid filter of similar type to the "white light" filter (see recommendation 3) and if possible shall be made up from the same constituent materials.

It is hoped that you will be able to signify agreement with Recommendations 1, 2, 3 and 4, but if not, the Committee will be glad to have a full statement of the grounds of your objections and of suggestions for the amendment of these recommendations.

The Committee would be glad to receive a definite recommendation on the colour-temperature at which you consider the standard lamp should be used if you have grounds for objecting to the colour-temperature of 2900°K suggested in recommendation 5. The Committee would also be glad to learn whether there are any grounds for objection to recommendation 6.

The Standard Filters.

The Committee does not wish at the moment, to propose a definite specification for the filters mentioned in recommendations 3 and 6. It desires, however, to lay certain information before you, and hopes to receive your comments and suggestions.

Two filters for these purposes have been in use at the National Physical Laboratory for the last few years. One of these, the "white light" filter, consists of a twin cell of colourless optical glass having three parallel walls which divide the cell into two compartments, each 1.000 cm internal thickness. One of these compartments is filled with solution A, the other with solution B; these solutions have the following compositions:

A:	Cupric sulphate	2.30 gm
	Ammonia (density 0.90)	230 ccs
	Distilled water to	1000 ccs
B:	Cupric sulphate	15.0 gm
	Cobalt sulphate	15.0 gm
	Distilled water to	1000 ccs

If the density of the ammonia differs from 0.90, the volume given in the above specification should be modified to give the same ammonia content in the solution.

The second, the "lamp-rating" filter, consists of a cell similar in construction to that used for the "white light" filter which contains solutions C and D of the following compositions:

C:	Cupric sulphate	1.41 gm
	Ammonia (density 0.90)	141 ccs
	Distilled water to	1000 ccs
D:	Cupric sulphate	11.0 gm
	Cobalt sulphate	8.5 gm
	Distilled water to	1000 ccs

The lamp-rating filter does not of course enter directly into the routine work of colour measurement. It is only employed in the preliminary process of determining the proper voltage at which to operate the standard gas-filled lamp in accordance with the procedure suggested in recommendation 4.

The colour temperature of a gas-filled lamp, when it matches the colour of a 2360°K source used in conjunction with this filter, is believed to be nearly 2900°K.

The "white-light" filter must always be used in combination with the gas-filled lamp to provide a standard "white" light for colorimetric measurements.

Assuming 2900°K as the colour temperature of the gas-filled lamp, the colour temperature of the "white" light thus obtained is in the neighbourhood of 4800°K. This is somewhat yellower than "mean noon daylight" at Washington and slightly yellower than the 5000°K

black body which has been arbitrarily assumed to represent "white" in much of the recent theoretical work on colorimetric problems.

These two filters, and the "standard white light" which results from their use, were adopted by the National Physical Laboratory, because some measure of standardisation in the British colour industries was urgently needed: at that time no alternative suggestions had been put forward. This standard has been in use for some time past in the laboratories of the British Research Association for the Woollen and Worsted Industries, the British Paint and Varnish Research Association and some other colorimetric laboratories. The calibration of instruments to this standard is one of the established tests of the National Physical Laboratory.

Since the adoption of this standard by the National Physical Laboratory, a comprehensive investigation of a series of filters designed to give artificial "white" light when used in conjunction with lamps of various colour temperatures has been conducted at the Bureau of Standards. The results obtained are contained in a paper by Messrs. Davis and Gibson on "Artificial Sunlight for Photographic Sensitometry" printed in the Transactions of the Society of Motion Picture Engineers, Vol. XII, No. 33, 1928, pp. 225–236, and in the Proceedings of the Seventh International Congress of Photography, London 1928, pp. 161–170. This paper gives data for a series of filters which will give a standard white light when used with sources at colour temperatures ranging from 2300°K to 3000°K. This white light has been selected to give a colour match with "mean noon daylight at Washington" as determined by the energy distribution measurements of Abbot. This energy distribution does not correspond very closely to that of any black body.

Each filter of this series consists of two solutions in a twin cell, identical with that used in the National Physical Laboratory filters already described. The solutions are very similar in constitution to the National Physical Laboratory filters, the principal difference being that the ammonia is replaced by pyridine. The energy distributions, when the filters are adjusted to the same colour temperature, are practically identical whether ammonia or pyridine is used. The objections to ammonia advanced by Messrs. Davis and Gibson are that it attacks the glass of the cells and bottles and that it is very volatile.

One of the Davis-Gibson filters, namely that which steps directly from 2360°K to daylight, has been adopted by the Seventh International Photographic Congress, 1928, in the specification of a standard white light for photographic sensitometry. This filter is not suitable for use in constructing a standard light source for colorimetry owing to the relatively low intensity of illumination which can be obtained with it. However a suitable filter could be extracted from the series for use with a gas-filled lamp. For instance if 2900°K were adopted as the desirable colour temperature for the gas-filled lamp, the Davis-Gibson filter which steps up from 2900°K to daylight could be employed.

The two solutions for this filter have the following constitutions:

A:	Cupric sulphate	2.337 gm
	Mannite	2.337 gms
	Pyridine	30.0 ccs
	Distilled water to	1000 ccs
B:	Cobalt ammonium sulphate	15.58 gms
	Cupric sulphate	18.30 gms
	Sulphuric acid (s.g. 1.835)	10.0 ccs
	Distilled water to	1000 ccs

The Mannite in solution A is added as a preservative. The pyridine employed had a strength of 98.4%.

If this filter were employed for colorimetric work it would be necessary to design another filter, using the same materials, to step from 2360°K to 2900°K for lamp-rating inaccordance with recommendation 4, above.

The Committee wishes to put before you the following summary of the position, and to ask your comments and suggestions on the points mentioned:

(a) It appears evident that the most satisfactory filter for colorimetric purposes is of one or other of the types described above, namely a filter in which the blueness is obtained by cupric sulphate treated either with ammonia or pyridine, the outstanding defects of the spectrophotometric curve being corrected by a second solution of cupric and cobalt sulphates. This is the only type of filter that has been proposed which gives a reasonably satisfactory energy distribution and is accurately reproducible from specification.

(b) The choice of ammonia or pyridine should depend on practical considerations such as ease of procuring the necessary materials of the requisite purity, the ease with which adequate tests of their purity may be made, their stability, their freedom from destructive action on cells and bottles, etc.

(c) The only information on these points which has been presented to the Committee, is as follows:

No difficulty has been experienced at the National Physical Laboratory, and no difficulty has been reported by any of the other laboratories in which the N.P.L. standard white light has been employed, due to deterioration of the glass of the cells or bottles containing the ammoniated copper sulphate solution. Also, no difficulty has been experienced from change of concentration owing to the volatility of the ammonia either in storage in glass stoppered bottles or in the cells, when the latter are closed with a covering glass sealed with vaseline. Although it is recommended by the National Physical Laboratory that a filter should not be used for more than two weeks without refilling from the stock bottles, and that fresh stock solutions should be made up every three months, the changes actually observed after periods of six months have been negligible.

The Committee would be glad to know whether any difficulty due to this cause has in fact been found in countries where the usual laboratory temperatures are much higher than in Britain.

One advantage of ammonia, is that its strength is easily estimated with a hydrometer, no special chemical equipment or skill being required. On the other hand, the strength of the pyridine has to be tested by titration with sulphuric acid, using methyl orange as an indicator. This requires chemical facilities which may not normally be found in a laboratory primarily devoted to colorimetric work. Moreover this particular titration has a very indefinite end-point and presents difficulty at least to chemists who have not extensive experience in its use. It may be mentioned that fears were expressed by many speakers at the Seventh International Photographic Congress held in London last year, that it would be difficult to obtain pyridine commercially of sufficient purity.

Several of the Davis-Gibson filters have been made up at the National Physical Laboratory using C. P. pyridine obtained from commercial dealers without taking any precautions about purity. The properties of these filters agreed so closely with those published by Davis and Gibson that we may conclude, so far as Great Britain is concerned, that pyridine can be obtained commercially of sufficient purity to obviate the need for any elaborate precautions.

(d) The Committee would like such advice or information as you may possess which will supplement the information in (c) above and lead to a definite preference for one or other alternative.

In presenting for your consideration the various questions raised in this communication the secretariat Committee think it ought to be borne in mind that, as far as they are aware, no standard white light for practical colorimetry has been adopted, even provisionally, except in Great Britain. The National Physical Laboratory standard has been in use for some time in a number of Industrial and other laboratories. A change in the standard will cause much inconvenience by introducing a discontinuity in the investigations being carried out in these laboratories. This appears to be a cogent reason for adopting the N.P.L. standard, as at present specified, unless there is evidence that its adoption in other countries is open to serious objection. If strong grounds exist for changing this standard, either in its entirety or in some

special detail, the Committee feels that the change should be made despite the inconvenience inevitably caused to those already using the standard, if general international agreement can thereby be secured. They hope that the views expressed in the replies to this communication will enable them to frame definite recommendations with the assurance that they will prove generally acceptable.

Since the inconvenience arising from any changes will be more serious the longer a decision is delayed, it is hoped that the presentation of any adverse criticism of these proposals will be regarded as a matter of great urgency and importance.

June 13th, 1929.

Discussion of the above communication will be contributed by Mr. Raymond Davis and Dr. K. S. Gibson.

If found desirable it may be arranged to continue discussion of the above communication from the British Committe Saturday afternoon, after the Business Session.

Saturday, October 26
2:00 P.M.

BUSINESS SESSION
AND
READING OF ANY PAPERS
PASSED AT PREVIOUS SESSIONS

THE OPTICAL SOCIETY OF AMERICA

Purpose and Scope

The Optical Society of America is a national organization devoted to the advancement of optics and the service of all who are interested in any phase of that science—be it fundamental research, the manufacture of optical instruments and products, or the application of optical technics to any of various purposes in science and industry.

The activities of the Optical Society, its meetings, and the contents of its Journal will be found to be of interest and service to an extensive and diverse clientele:—physicists, chemists, biologists, psychologists, ophthalmologists, optometrists, astronomers, mineralogists, artists, illuminating engineers, manufacturers, and various technologists who are concerned with the application of optical methods. It solicits the support and membership of all persons "interested in optics" whatever the specific interest may be.

Applications for Membership

All persons desiring to join the society or cooperate with it in any way are invited to communicate with the president or the secretary.

Detailed information concerning the society, classes of membership and dues, and membership application blanks may be obtained at the registration desk (Room 220, second floor Rockefeller Hall) at any time during this meeting.

Officers and Executive Council
1928–1929

The executive council consists of the president, the vice-president, the secretary, the treasurer, the past president, the editor-in-chief of the Journal, the assistant editor-in-chief and business manager of the Journal, as *ex officio* members; and four members at large elected by the society.

President	Irwin G. Priest
Vice-President	Loyd A. Jones
Secretary	L. B. Tuckerman
Treasurer	Adolph Lomb
Editor-in-Chief	Paul D. Foote
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Past President	W. E. Forsythe

Elected Members of Council

L. R. Ingersoll	A. H. Pfund
P. E. Klopsteg	W. F. Meggers

For further information address the secretary

L. B. Tuckerman
Bureau of Standards
Washington, D. C.

GENERAL INFORMATION

Hotel Headquarters:

ITHACA HOTEL: Corner State and Aurora Streets. Reached by any street car from railroad stations or from the place of meeting.

Meeting Place:

Rockefeller Hall (Department of Physics), Cornell University.
Registration and headquarters in Room 220, second floor.
Reading of papers in Room B, second floor, S. W. corner.
(Rockefeller Hall may be reached by any street car going east on State Street. Those who motor to Ithaca will find convenient parking space on the Campus during the sessions.)

Entertainment:

The local committee is mailing a letter direct from Ithaca, giving details of plans for the meeting and asking for notification from those who plan to attend.

Hotel Rates:

THE ITHACA HOTEL: Corner State and Aurora Streets.

Single room with bath	$4.00
Double room with bath, (twin beds)	$7.00–8.00
Double room with bath, (double bed)	$6.00–7.00
Single room without bath	$2.50
Double room without bath, (twin beds)	$5.00
Double room without bath (double bed)	$4.00

THE CLINTON HOTEL: Corner Cayuga and Seneca Streets.

Rooms with bath	$3.00 per person
Rooms without bath	$2.00 per person

Street cars pass within one block of the Clinton Hotel.

The two hotels are three blocks distant from each other.